HOSPITAL AND MEDICAL FACILITIES SERIES
(Under the Hill-Burton Program)

design-
equipment

planning the LABORATORY for the General Hospital

U.S. DEPARTMENT OF HEALTH,
Public Healt
Division of Hospital ar
Architectural and E
Washington

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
From ARCHITECTURAL RECORD, Vol. 129, No. 2, 160-168, February 1961

This is a reprinting of an unnumbered
Public Health Service publication with
the same title previously issued in 1961.

Public Health Service Publication No. 930-D-10

Reprinted March 1963

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. - Price 15 cents.

Well-designed laboratories attract pathologists. Good pathologists breed good medicine. Competent doctors are drawn to communities where advanced laboratory medicine flourishes. Qualified, registered technologists seek employment in this environment.

No matter what the size of the hospital, pathology as a diagnostic tool is as vital in the care of patients as the other major branches of medicine. In addition to performing tests, laboratories promote continuing educational activities within hospitals. From the laboratory flows the teaching material for clinical pathological conferences, staff meetings, reviews of cases, critical evaluation of diagnoses, and assessment of therapy. The laboratory is the basis for the Tissue Committee, The Medical Audit Committee, The Hospital Infection Committee, and numerous other committees.

No hospital should be without the services of well-trained pathologists, working in well-equipped laboratories and assisted by registered technologists. This is just as important in small rural hospitals as it is for large urban institutions and university hospitals. It must be remembered that of 5419 short-term general hospitals in the United States, 4516 hospitals (about 83 per cent) have less than 200 beds. A critical tissue diagnosis, an exact biochemical measurement or bacteriological procedure is as important to a patient in a small suburban hospital as it is for one in a large medical center: he should not be deprived of these diagnostic possibilities.

The striking pathology "explosion" of the past few years is evidence that the study of disease by laboratory methods substantially improves the service of the hospital to the patient. The volume of laboratory studies may be expected to continue to increase.

While these truisms are generally accepted by most physicians, they should also be fundamental in the thinking of all architects and hospital administrators who are responsible for the design, construction, and management of hospitals. The cost of building and equipping adequate hospital laboratory facilities can and must be met because they are as vital to the function of the hospital as the operating rooms or the kitchens. A hospital laboratory serves not only the hospitalized patient but also, in the absence of a private pathologist-directed laboratory, contributes to the community through its service to the ambulant patient.

The determination of adequate size for this inevitable expansion must be based on good records, statistical analyses, and sound fiscal planning. Experience has shown that as hospitals of 100 beds or less are more fully utilized, a greater need for better laboratory services becomes evident, and as a result, these hospitals usually expand within a few years.

The principle of cooperative effort among several small hospitals in procuring the services of an experienced pathologist has been accepted and has proved its value. Frozen tissue examinations, consultations, and teaching activities are made available on regular schedules. Pooling of physical and technical resources by several hospitals permits the establishment of centralized laboratory facilities which can furnish more complex diagnostic procedures to each participating hospital than would be possible with the limited resources of each hospital. A fine example of this concept has been created at the North Central Associated Laboratories in Elyria, Ohio.

The introduction of automation devices, although costly at present, suggests that an increased number of tests can be prepared without a proportionate increase in space. This has opened an entirely new vista for medical diagnosis, as well as economical growth and development, particularly for small hospitals that are unable to maintain complete diagnostic services and must share facilities.

In small hospitals of 25 beds or less, collecting stations may be established for specimens, which are sent to a neighboring central pathologist-directed laboratory. Specimens can be easily delivered by using the local and interurban transportation systems. The development of communication systems utilizing short wave radio, private telephone lines and teletype circuits permits immediate and rapid transmission of the reports from the central laboratory to the member hospitals.

Even a small 100-bed hospital can justify and interest a competent, energetic pathologist. Experience has shown that as soon as a pathologist assumes responsibility of directing a laboratory, a distinct upgrading of the quality of medical care ensues, the volume of laboratory studies increases, consultation among the staff is stimulated, and the patient's welfare is improved.

The laboratory must be designed according to progressive architectural and medical principles which insure economical use of space, efficient utilization of trained personnel, and adoption of sound systems of management.

The hospital architect should be chosen with care from among those who have the necessary experience and background. The hospital administrator should be assured that the laboratory will be solvent financially so that he will not be impelled to "pinch pennies" in the design and construction of this department. The services of a qualified pathologist, experienced in the organization, personnel requirements, and the physical requirements of hospital laboratories, should be procured to write the laboratory program and consult with the architect in the design of the facilities to assure meeting the needs of the hospital and the community. This team—the pathologist, administrator, and architect—working together can design a laboratory for the present and include the potential for future expansion.

The *Manual for Laboratory Planning and Design* by the author of this article and published by the College of American Pathologists discusses many of the problems of laboratory design.

ACKNOWLEDGMENTS

This material was developed by the Division of Hospital and Medical Facilities of the Public Health Service in collaboration with the College of American Pathologists.

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PLANNING THE LABORATORY FOR THE GENERAL HOSPITAL

TOWARD BETTER PLANNING

With the increasing demand for laboratory services, the hospital often finds itself with a crowded laboratory department which is hampered in its operations because of limited space. Perhaps the reason this situation prevails is that insufficient emphasis has been placed on the design and physical requirements for the laboratory.

The first essential in planning a laboratory department is a better understanding of the laboratory requirements by pathologists, architects, hospital officials and trustees, and hospital professional staffs.

Pathologists should become acquainted with the needs for physical space and equipment so that they can accurately describe and support these requirements with the basic data needed for planning a hospital laboratory.

The architect, too, should become acquainted with the functions, equipment, space, and personnel required in the various units of the laboratory so that he can more efficiently lay out the design, develop the plans, and complete the specifications.

The hospital administrator and the trustees should be informed of the financial and clinical advantages of having adequate physical space and equipment to maintain a laboratory service. The speed and accuracy in determining a diagnosis, as well as the necessity to expedite a large volume of tests, depend on well-planned, ample laboratory facilities.

The related professional staffs should also be made aware of the importance of having a smoothly functioning laboratory.

TEAM APPROACH AND THE PROGRAM

The laboratory design should be the responsibility of a team comprised of the pathologist, the administrator or owner, and the architect. Each will have his sphere of responsibility: the pathologist to determine the requirements of space and equipment and to develop the program; the administrator or owner to review and approve them; and the architect, working with the pathologist, to incorporate these requirements within the structure.

Planning laboratory facilities—as in planning most areas—depends on the clarity of the proposed program. The program, as it relates to architectural planning and construction, is the written description of all requirements to be incorporated in the design of an area. In developing the laboratory program, the pathologist should realize that the architect may know little about the requirements for a specific laboratory. Therefore, the program should explain as fully as possible the services to be provided, the functions and procedures, the personnel required, working relationships, equipment required, and some concept of the space needed.

CONSIDERATIONS FOR DEVELOPING THE PROGRAM

The following checklist may be helpful in determining laboratory requirements:

1. Determine which services are to be provided
2. Determine space requirements to accommodate equipment and personnel in the following areas:
   a. Administrative
   b. Technical
   c. Auxiliary (includes washing, sterilizing, storage and locker facilities)
3. Divide the technical area into functions or units, such as: Hematology; Biochemistry; Parasitology; Blood Bank; Bacteriology; Histology; Urinalysis; Serology
4. Determine where the procedures are to be performed:
   a. Those to be combined in the same work area
   b. Those to be done in completely separate work areas
5. Estimate the volume of work in each area or unit, allowing for future increase in workload
6. Indicate the number of personnel requiring a work station in each unit
7. Describe the major equipment in each unit:
   a. If possible, indicate the linear feet of bench space required and how the space may be arranged. In many instances this can be determined only by an architectural study
   b. List the equipment that requires utility lines and indicate the location
   c. List equipment, such as refrigerators, centrifuges, hoods, desks, that may be jointly used by technologists from different work stations
8. Indicate the desirable functional arrangements. (For example, the bacteriology unit may be located at the extreme end of the laboratory, to reduce the contamination hazard, and the washing area should be next to the bacteriology unit; hematology may be next to the waiting room, adjoining the examination and specimen area)
9. Indicate which work units may be expected to expand. (It may be possible to locate these areas at one end of the department to facilitate efficient, coordinated expansion)
10. In the technical area, a standard module for the work areas is suggested (for instance, a module of 10 by 20 ft as is used in these plans). This module can be worked out in collaboration with the architect. By using a standard module, the architect can accommodate more easily the laboratory within the fenestration and structural patterns of the building. A standard module will also facilitate future rearrangement of the department
11. List the utilities to be provided and any special requirements for instruments such as electronic counters. Separate electrical circuits for some electronic instruments are necessary in order to avoid fluctuating voltage, which affects the accuracy of these instruments
12. List environmental requirements, such as light, ventilation, color, and isolation of equipment that may be noisy or may produce heat when used

PRELIMINARY PLANNING

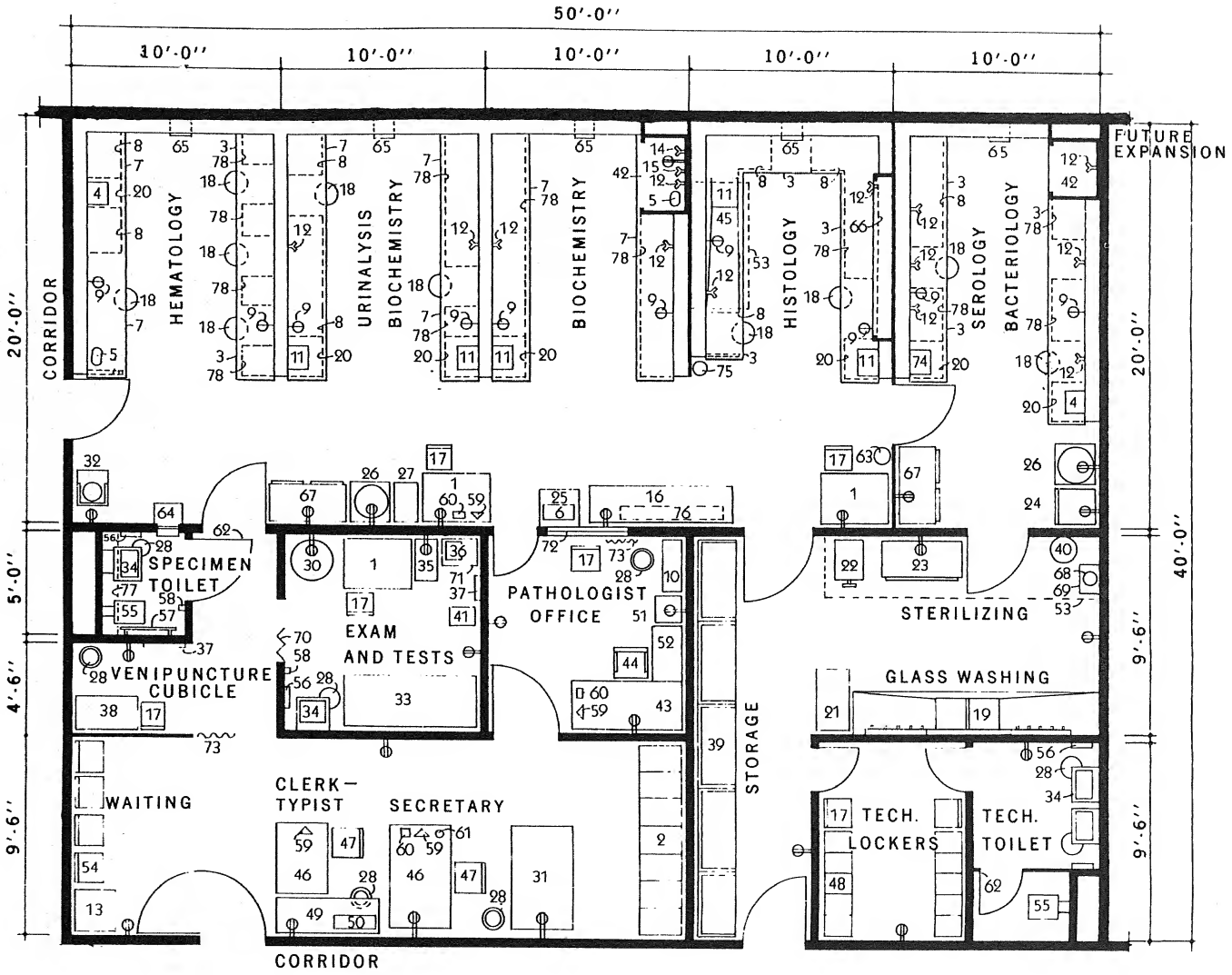
Locate the department as favorably as possible for the laboratory staff and the ambulant inpatients and outpatients. A space on the first floor near an elevator is preferable. However, as first floor space is in great demand and it is not possible to place all departments in this preferred location, some compromise may be necessary. Also, another determinant in locating the laboratory is the consideration for future expansion.

In determining the overall size of the laboratory, the first concern is the individual technical units. It is only after the size of these units has been established and an architectural layout has been developed to fit the program that the sum of the areas can accurately reflect the size of the laboratory department.

The square-foot-per-bed ratio is no longer considered a desirable guide in determining the size of a hospital department because of the wide variation of such factors as type and size of hospital, pattern of usage, growth of the community, and medical practice. Plans for the laboratory area should be based on work volumes within specific

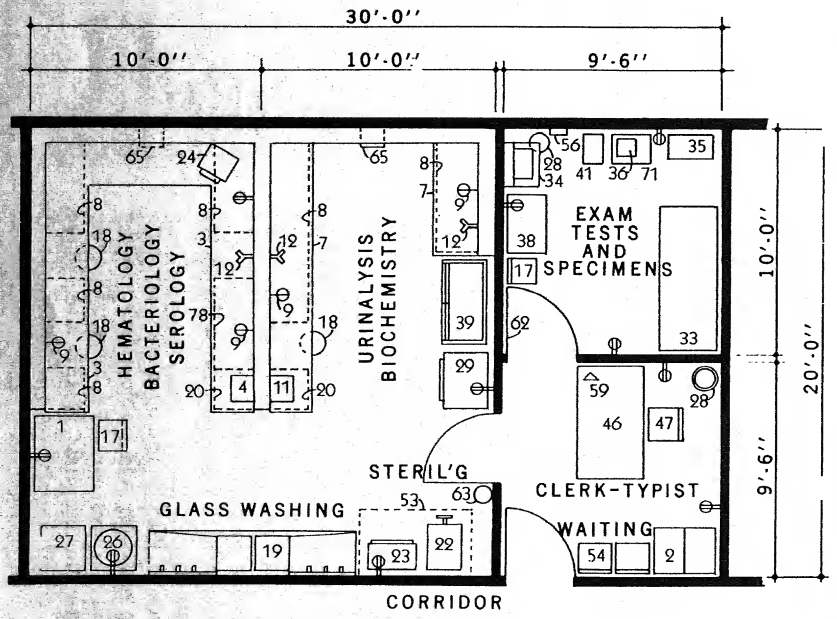
LEGEND

1. Desk, 30 by 40 in., single pedestal
2. Filing cabinet, letter size
3. Counter, 30-in. high
4. Staining sink
5. Cup sink
6. Analytical balance
7. Counter, 36-in. high
8. Cabinets with adjustable shelves, below counter
9. Electric strip outlets, continuous
10. Bookcase
11. Utility sink
12. Gas outlet
13. Table for magazines
14. Suction outlet
15. Compressed air outlet
16. Table for instruments
17. Straight chair
18. Stool
19. Two-compartment sink 8-in. deep; drainboards-noncorrosive metal; peg boards above drainboards
20. Cabinet with trash receptacle on inside of door
21. Utility cart
22. Laboratory pressure sterilizer
23. Hot air oven
24. Incubator
25. Shelf or table for analytical balance
26. Centrifuge
27. Table for Harvard trip balance
28. Waste paper receptacle
29. Refrigerator, 8 cu. ft.
30. Refrigerator, blood bank
31. Worktable
32. Micro-hematocrit centrifuge
33. Examination table
34. Lavatory
35. Basal metabolism apparatus
36. Electrocardiograph
37. Hook strip
38. Table, 24 by 36 in.
39. Storage cabinets
40. Water still, 2-5 gals. per hr.
41. Adult scale
42. Fume hood
43. Double-pedestal office desk
44. Office chair, swivel, with arms
45. Noncorrosive metal work surface; pitch to sink
46. Typewriter desk
47. Posture chair
48. Technicians' lockers
49. Specimen receiving table
50. Request file with pigeon holes
51. Slide file cabinet
52. Microscope table
53. Exhaust hood
54. Easy chair
55. Wall-hung water closet
56. Paper towel dispenser
57. Grab bar, continuous
58. Emergency call station (push button) connected to buzzer at secretary's desk

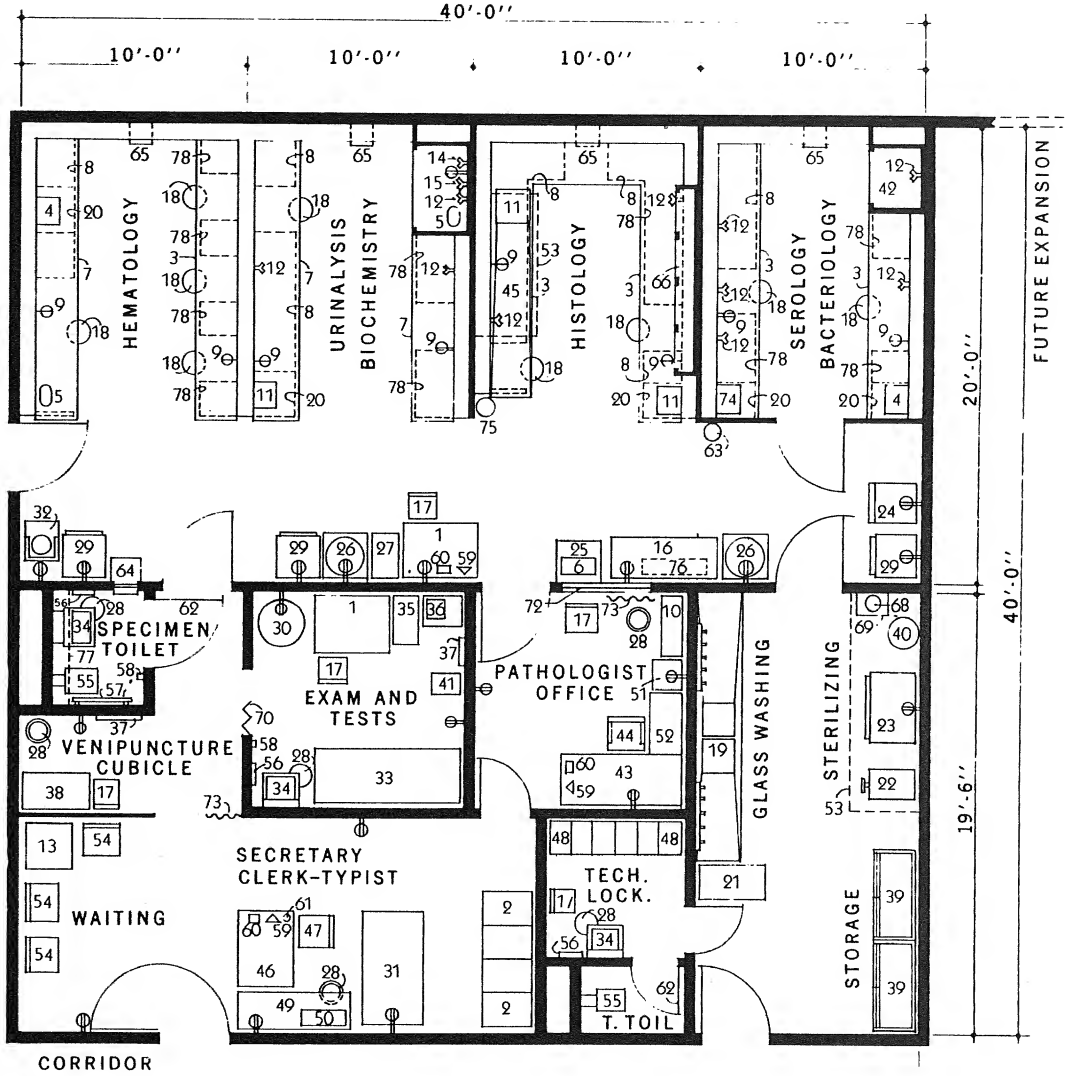


Plan A (70,000-120,000 Tests Annually)
for Average Size of 150-200 Beds

59. Telephone outlet
60. Intercommunication system outlet
61. Buzzer at receptionist's desk from emergency calling stations
62. Hook on toilet-side of door
63. Fire extinguisher
64. Pass-through between toilet and laboratory
65. Exhaust air grills near floor
66. Wall cabinet
67. Refrigerator, 11 cu. ft.
68. Pipette washer
69. Shelf, for pipette washer, 10 in. above floor
70. Folding door
71. Table for electrocardiograph
72. Window
73. Curtain
74. Sink with electric waste disposal
75. Carbon dioxide cylinder
76. Gas cylinders under table
77. Shelf for urine bottles
78. Drawers with adjustable shelves, below counter



Plan C (20,000-30,000 Tests Annually) for Less Than 100 Beds



Plan B (40,000-75,000 Tests Annually) for Average Size of 100-150 Beds

ranges, such as 40,000-75,000 tests, or 75,000-120,000 tests. The key to this method is to estimate the work volume and its breakdown into work units for hospitals of different sizes. This points up the necessity for maintaining accurate records, which, aside from their clinical and fiscal use, provide data for planning a laboratory service.

The following is an outline of the procedure which may be used in estimating needed laboratory space, based on the number of tests performed, personnel, and equipment.

1. Break down the total volume of work into units, such as hematology, urinalysis, chemistry, as previously noted.

2. Determine the number of technologists required in each department. The data shown in Table I may be used as a basis for this determination.

3. Determine the necessary equipment and space for the number of technologists required.

For the purpose of developing guide material, the Architectural and Engineering Branch of the Division of Hospital and Medical Facilities collected data from 360 hospitals in addition to the data compiled by the Committee on Laboratory Planning of the College of American Pathologists. Tables II, III, IV, and V present these data.

Many laboratories show annual workload increases of about 10 per cent, thus doubling the work volume in approximately nine years. This annual increase should be considered during the planning stage of the laboratory. However, improved techniques and automation suggest that it may be possible for a greater volume of work to be done in the same work area size.

LABORATORY GUIDE PLAN

Plan A—is a suggested plan for a hospital laboratory service with an estimated workload of 70,000 to 120,000 laboratory tests annually. For planning purposes, this laboratory is designed to serve a general hospital of 150 to 200 beds. Designing for a range of 69,000 to 163,000 tests (shown in Table II) was not considered practical, since a laboratory plan for 14 technologists (shown as 13.3 in Table IV) would be excessive for a staff of only 6 technologists (shown as 5.9 in Table IV) for the median workload range. By adjusting the work volume of the data shown in Table IV to two thirds of the high annual volume for each laboratory unit, the technical staff required would be 6 to 10 technologists, based on the tests performed annually per technologist, as shown in Table I. The nontechnical staff would include one or more laboratory helpers in the glasswashing and sterilizing unit and a clerk-typist and secretary in the administrative unit.

The laboratory services of a general hospital having this work volume would require work areas for six main technical units: hematology, blood bank, urinalysis, biochemistry, histology, and serology-bacteriology.

The block plan has been utilized here, as it provides a good functional relationship for all units. The pathologist's office in the center provides for easy supervision of the work stations; the hematology unit is near the waiting room; the bacteriology unit is at the end of the laboratory, yet near the washing and sterilizing areas; and the histology unit is near the pathologist's office.

Other schemes similar to that shown in Plan D or a typical wing arrangement with a corridor down the center would also be satisfactory.

In the technical area of Plan A, the open plan arrangement (except for the histology and serology-bacteriology units) has several advantages over the "separate room for each unit" scheme for hospitals of this size. These advantages include: easier supervision; common use of such equipment as desks, refrigerators, and centrifuges;

TABLE I
TESTS PERFORMED ANNUALLY PER MEDICAL TECHNOLOGIST*

Laboratory Unit	Tests
Hematology	13,400
Urinalysis	30,720
Serology	11,520
Biochemistry	9,600
Bacteriology	7,680
Histology	3,840
Parasitology	9,600

* These figures were derived from data developed by Seward E. Owen and Edmund P. Finch, presented in two articles published in *Modern Hospital*, June and October, 1957. Titles of the articles are: "How to Calculate the Laboratory Work Load" and "How to Measure Laboratory Productivity"

TABLE II
TESTS PERFORMED ANNUALLY IN GENERAL HOSPITALS

Hospital Bed Size	Number of Tests		
	Low	High	Median
50- 99	12,000	25,000	19,000
100-149	24,000	75,000	39,000
150-200	55,000	163,000	69,000

TABLE III
UTILIZATION INDEX OF LABORATORY SERVICES IN GENERAL HOSPITALS

Hospital Bed Size	Tests per Patient Day		
	Low	High	Median
100-149	1.05	2.02	1.29
150-200	1.08	2.67	1.32

TABLE IV
TESTS PERFORMED ANNUALLY IN EACH LABORATORY UNIT

General Hospitals—150-200 Beds

Unit	Low	High	Median	Technologists Required	
				Median	High
Urinalysis	6,200	20,100	11,300	0.4	.7
Hematology	29,800	81,200	35,800	2.5	5.6
Serology	3,600	13,500	6,800	0.6	1.1
Biochemistry	2,300	19,600	6,600	0.7	2.0
Parasitology*	—	—	—	—	—
Bacteriology	400	4,700	1,800	0.2	0.6
Histology	700	5,100	1,800	0.5	1.3
Basal Metabolism	30	700	400		
Electrocardiograms	800	4,200	1,300		
Blood Bank Tests	130	23,200	4,500	1.0	2.0
Transfusions	800	2,000	1,000		
Other	500	9,600	1,700		
			TOTALS	5.9	13.3

* Included with urinalysis

TABLE V
TESTS PERFORMED ANNUALLY IN EACH LABORATORY UNIT

General Hospitals—100-149 Beds

Unit	Low	High	Median	Technologists Required	
				Median	High
Urinalysis	3,000	9,000	4,800	0.2	0.3
Hematology	9,000	37,000	20,200	1.4	2.5
Serology	220	5,600	3,500	0.3	0.4
Biochemistry	1,300	5,300	2,800	0.3	0.6
Bacteriology	85	3,800	700	0.09	0.5
Histology	700	3,100	1,500	0.4	0.8
Parasitology	200	250	200	0.02	0.02
Basal Metabolism	20	300	60	—	—
Electrocardiograms	500	3,300	650	0.5	1.0
Blood Bank Tests	20	9,200	2,800		
Tranfusions	400	1,300	700		
Other	80	7,300	400		
			TOTALS	3.21	6.12

flexible use of personnel; and more available space since many doors and partitions are eliminated. If desired, partitions could be erected between each unit, as indicated on the plan for the histology and serology-bacteriology units.

Laboratory Module for Technical Area

Maximum flexibility is desirable in the technical work areas of the laboratory department. In the plans, this has been achieved by using a module of approximately 10 by 20 ft, with a similar arrangement for each module. Each one consists of two standard laboratory workbenches 12 ft long, 30 in. deep, with a working surface or counter of about 23 in., and a reagent shelf. Knee-spaces are indicated where needed for personnel who perform tests from a sitting position. Drawers, cabinets, and shelves are provided below the work counter for daily equipment and supplies. This arrangement provides a 5-ft aisle between workbenches, which is considered optimum for movement within the working area. Equipment such as centrifuges, refrigerators, and desks, which may be used jointly by the personnel, is located opposite the units along the interior of the technical work area.

Technical Areas

Hematology-blood bank unit, a standard module is assigned to the hematology-blood bank unit. One half of this module is provided with a workbench for procedures such as hemoglobin tests, sedimentation rates, staining, and washing of pipettes (in Plan A, counter No. 7 on left side of unit). Kneespace and storage cabinets are provided below the counter. In the other half of the module, a workbench 30 in. high, with three kneespaces, is provided for technologists who are seated during tests, such as those involving microscopic procedures.

The micro-hematocrit centrifuge, because of its noise and vibration when in use, is placed in the general technical area along the interior wall directly opposite the hematology unit. The other equipment needed by this work unit, such as a refrigerator, centrifuge, and recording desk, is located conveniently opposite the unit, where it is shared with the urinalysis and the chemistry units.

It is assumed that the laboratory will obtain blood for transfusions from other sources, and, therefore, needs only facilities for blood storage. A blood bank refrigerator is provided for this purpose in the examination and test room. Compatibility tests on the blood are done in the hematology unit. A hospital which operates a selfcontained blood bank, that is, collects and does complete processing of all blood, should provide a separate bleeding room, processing laboratory, donors' recovery room, and an office available for preliminary physical examinations.

Urinalysis unit, the urinalysis unit is assigned one half of a standard module, consisting of a workbench, 12 linear ft, 30 in. high, and serves as the work area for the microscopic and chemical examinations. Five linear ft of the workbench and a kneespace are provided for personnel performing the microscopic examinations; the remainder of the workbench is used for the chemical examinations. A sink located at one end of the workbench provides a continuous working surface for the technologists.

Biochemistry unit, the biochemistry unit requires an area that occupies one and a half standard laboratory modules. The half module is shared with the urinalysis unit and is used for the necessary preliminary procedures that are done prior to the actual chemical analyses. A kneespace is provided in this workbench for personnel who perform titrations and other procedures while seated. The adjoining module provides workbench area where a variety of chemical procedures may be performed and includes a fume hood for removal of vapors and gases.

The workbenches for the chemical procedures are about 36 in. high, with drawers and cabinets below. The reagent shelves are used to hold the chemicals needed during the procedures. Two utility sinks are provided, one in each chemistry work area. Apparatus used in this unit is cleaned by the personnel in the unit; tests tubes, pipettes, and flasks are sent to the central glasswashing area nearby.

An instrument table 36 in. high is located along the interior wall opposite this unit where chemical apparatus, such as colorimeter, flame photometer, spectrophotometer, and carbon dioxide gas apparatus are placed. Adjacent to the instrument table is an analytical balance on a vibration-free table or other type of support. By placing this apparatus away from the busy preparation and test procedure work areas, personnel can use the apparatus without interference from other procedures. It also lessens the possibility of damage to the equipment by the accidental spillage or splattering of chemical reagents.

A centrifuge, refrigerator, and desk are provided along the interior wall opposite the unit for the use of the personnel in this unit. The desk and refrigerator are shared with the urinalysis and the hematology units.

Histology unit, the histology unit is assigned a standard module, separated from the other units by a partition to prevent odors from spreading to other areas. It is located near the pathologist's office since the medical technologist here works under his direction and supervision.

Along one half of the module, an area is utilized by the pathologist to examine surgical and autopsy specimens and to select the tissues for slide sections to be prepared by the technologist. An exhaust hood is provided over this section, as shown in the plan (No. 53) to draw off disagreeable odors from specimens and solutions. The remainder of the module is used for the processing and staining of tissues. Kneespaces are provided, one at each of the specialized work areas. The workbench is 30 in. high with a 22- or 23-in. deep working area, cabinets and drawers below the counter, and a reagent shelf. Wall-hung cabinets are provided for additional storage. A utility sink is provided at the end of the workbench.

Serology-bacteriology unit, the serology and bacteriology work is combined in one standard laboratory module, where a half module is assigned to each unit. Culture media for use in bacteriology are prepared in the bacteriology work area and sent to the sterilizing unit for sterilization. Parasitology may be performed in either the bacteriology or the urinalysis unit.

The workbenches are 30 in. high with a 22- or 23- in. deep working area, and are provided with reagent shelves. A kneespace is provided in each workbench since most of the procedures are done in a sitting position. A utility sink is provided for the personnel in both units, but the bacteriology unit also requires a sink for the staining of slides. A fume hood is provided to prevent the spread of possible infection to personnel when preparing specimens from suspect cases of tuberculosis, fungus, or virus diseases. The stool cultures also may be prepared here to reduce the spread of odors to other work areas.

A centrifuge, refrigerator, and incubator are provided along the interior wall within the unit. A desk is also conveniently located for the use of the personnel.

This module is partitioned and separated from the other

units by a door to reduce contamination of air and the hazard of infection to personnel in the other lab areas.

Administrative Area

The administrative area is separated from the technical work areas so that the nonlaboratory personnel need not enter the technical areas. This is the central control and collection point for receiving specimens and is the reception area for the patients and the hospital staff who come to the laboratory.

Waiting room, a waiting area, with conventional waiting room furnishings, is provided for the ambulant patients. In this area, a desk is provided for a clerk-typist. An intercommunication system between the technical areas of the laboratory and the clerk-typist is recommended This enables her to quickly notify the technical personnel when a patient arrives and also to transfer phone calls for information concerning a laboratory report.

The pathologist's secretary is also located in this area, near the pathologist's office. She takes dictation and handles all the pathologist's correspondence, surgical pathological reports, and autopsy protocols.

Venipuncture cubicle, a venipuncture cubicle is provided where blood specimens are taken from the ambulant patients sent to the laboratory.

Specimen toilet, a specimen toilet is provided in this area for the collection of urine and stool specimens; a pass window opens directly into the technical area near the urinalysis unit.

Basal metabolism-electrocardiography room, a room is also located here for basal metabolism tests and electrocardiograms, and when necessary, to obtain blood from donors. A desk is provided in this room to permit handling of paper work. A lavatory is also provided.

Pathologist's office, the pathologist's office is located so that he may have easy access to the technical areas of the laboratory, particularly the histology unit. This office is separated by a glass partition which permits the pathologist to observe the technical work areas. A draw curtain may be used when he desires privacy. Those who wish to consult the pathologist have access to his office through an entrance from the administrative area.

A table or working surface suitable for a microscope is provided for the pathologist so that he may examine the tissue slides undisturbed. Other essential office furniture includes a bookcase, chair, and files for slides.

Auxiliary Service Areas

The auxiliary service units are located adjacent to the administrative area and are easily accessible to the technical areas.

Glasswashing and sterilizing unit, the glasswashing and sterilizing unit is close to the serology-bacteriology and the biochemistry units which will utilize such services more often than the other units. A separate door leads directly into the serology-bacteriology unit so that contaminated glassware need not be transported through other work areas.

Within this unit are located a water still, pressure sterilizer, sterilizing oven, and pipette washer. Storage cabinets are also provided for stock items of glassware, chemicals, and reagents. A hood over the sterilizers and water still is used to exhaust the heat generated by the equipment. Utility carts used to transport dirty glassware from the various laboratory units to this area are parked in this unit.

Locker and toilet facilities, separate locker and toilet facilities are provided within the laboratory department for the medical technologists. This convenience reduces the time personnel must be away from the work areas. Since most medical technologists are females, lockers have been provided for them in the department. However, where male technologists are employed, lockers should also be provided for them, either in the laboratory or in another location.

Optional services, clinical photography, medical illustration, and research facilities are not included in the plan because of their specialized requirements. If these services are to be part of the laboratory department, revision and expansion of the plan will be necessary.

GUIDE PLANS FOR SMALLER HOSPITAL LABORATORIES

Plan B—a suggested guide for a general hospital laboratory service having an anticipated annual workload of 40,000 to 75,000 tests. The estimated technical staff required to handle this workload is 4 to 7 medical technologists, based on the annual workload per technologist (Tables I and V). The nontechnical staff would include one or more laboratory helpers in the glasswashing and sterilizing unit and a secretary to handle the administrative work.

Many hospitals having laboratory services within this workload range employ a pathologist on a part-time basis. However, as more pathologists become available and the steady growth of laboratory services continues, more hospitals will employ pathologists on a full-time basis. This plan, therefore, provides for a laboratory department having a full-time pathologist. It is assumed that a histology unit will be needed, since it is common practice for pathologists in hospitals so equipped to do the pathology for smaller hospitals in the area. Hence, the histology unit workload will be greater than if the pathologist were processing the work of only one hospital.

A laboratory service performing a yearly volume of 40,000 to 75,000 tests requires the same types of technical units as one that handles 70,000 to 120,000 laboratory tests. The space requirements for the technical work areas of the units are reduced, however, because the workload is less and fewer technologists are needed.

Technical, administrative, auxiliary areas, the plan provides four laboratory modules where the technical procedures performed includes hematology, urinalysis, biochemistry, histology, and serology-bacteriology. Only the biochemistry unit is reduced in area because of less work and simpler procedures. The decreased work volume in the other units does not warrant further reduction of their work areas.

The principle of having equipment such as centrifuges, refrigerators, and recording desks close to the working unit which is to use them was followed as in Plan A.

Because of the decreased workload, the working area and the space for clerical personnel also is reduced.

The glasswashing, sterilizing, storage space, and technicians' locker facilities also are reduced.

Plan D—presents a design which might be used for a laboratory service in a small hospital. It allots the same areas for the technical, administrative, and auxiliary service units that Plan B provides, but the total square footage is less. However, more difficulty is encountered in

providing as efficient a relationship between the administrative and auxiliary services and the technical laboratory units as in the plans for larger departments.

Plan C—a suggested plan for a general hospital laboratory service handling an annual workload of from 20,000 to 30,000 tests. The estimated technical staff required to handle this workload is 2 to 3 medical technologists, based on the workload per technologist and the annual volume of tests (Tables I and II). The nontechnical staff would include one laboratory helper and a clerk-typist.

The requirements for an efficient and functional laboratory design are often overlooked in a small hospital because of the relatively small work volume in each category and the simplicity of the tests performed. The utilization of the standard laboratory module previously described permits even the small laboratory to be divided into technical, administrative, and auxiliary service work areas where the technologists may work in an area designed for the specific task.

Because of the decreased workload in a laboratory of this size, it is feasible to combine the hematology, bacteriology, and serology units by providing half a module for hematology and the other half for bacteriology and serology. A second module is provided for urinalysis and biochemistry, storage space, and refrigerator. No histology unit is indicated as it is customary for a laboratory service of this size to send pathological specimens to a pathologist in a nearby hospital. Specimens requiring complex bacteriological and chemical procedures would also be sent to an outside laboratory for study. Only the more common and simple laboratory procedures would be done in these units.

A glasswashing and sterilizing area is provided directly opposite but apart from the technical work areas.

The administrative area provides a small waiting room where a clerk-typist receives patients and laboratory requests and specimens. In this area, a room is also provided for performing basal metabolism tests and electrocardiograms. This room also can be used for obtaining blood specimens from ambulant patients. No separate toilet facilities are provided for obtaining other laboratory specimens because such facilities in this size hospital often are located a short distance from the laboratory. Because of the small number of personnel in this laboratory service, no separate locker facilities are provided since the hospital would probably have a central locker and restroom.

UTILITY SERVICES

The utility service systems required in the operation of the laboratory include water, waste, gas, vacuum and compressed air. Because of the importance of these systems, the need for continuity of service, and the probability of future expansion, careful study is necessary in designing them for safety and efficiency.

Piping systems should not be exposed because they create housekeeping problems as dirt collectors and may be hazardous; many are noisy and unsightly. They should be located where they will be easily accessible for service and repairs with a minimum of disruption of normal laboratory services. A sufficient number of valves, traps, and cleanout openings should be installed and should be located so as to permit maximum use of the facilities during repairs.

Laboratory benches are usually placed at right angles to and adjoining outside walls to effectively utilize space. This location of the benches simplifies, to some extent, the arrangement of the piping systems by installing vertical lines in the outside wall and mounting the horizontal piping on this wall. (See figure 1.) This arrangement is particularly advantageous for the waste vent stacks which must be carried vertically to the roof. Removable panels between the bench islands on the outside wall provide easy access to the main piping systems and sectionalizing valves. Branch lines may be carried from the horizontal wall piping through the center of the island to serve the benches on both sides.

For safety purposes and to facilitate repairs, each individual piping system should be plainly identified by color, coding, or labeling. All waste piping should be of a noncorrosive material and should be discharged to a dilution pit or should be carried to a point in the piping system where the discharge will be diluted by waste from other areas.

Laboratory sinks should be made of noncorrosive material and should be designed for laboratory service. A waste grinder under the sink in the serology unit is highly desirable for disposal of clotted blood which may otherwise clog the drain.

Air conditioning and ventilation, air conditioning with a well-defined pattern of air movement is necessary to provide an acceptable environment in the laboratory. Chemical fumes, vapors, heat from equipment, plus the undesirability of open windows, all contribute to this need.

The ventilation requirements for each work unit should be carefully studied and definite air-flow patterns should be provided by proper location of supply and exhaust grilles and by regulating the quantities of air handled by each. Ceiling supply air grilles of a non-asperating type with low wall exhaust grilles, located so that air moves into the working areas and down to the floor for exhaust, are desirable. Fume hoods usually have integral exhaust systems and provision must be made in the ventilation system or by other means to supplement the air discharged through them. The exhaust ducts from fume hoods and the fans serving them should be made of noncorrosive materials and the discharge from them should be carried above the roof. A slightly negative pressure relative to other hospital areas should be maintained in the laboratories because of the contaminants and odors which originate in and are common to laboratories.

The exhaust air from the hoods in the biochemistry, histology, glass-washing-sterilizing, and serology-bacteriology units, including the air from the exhaust grilles in the histology and seriology-bacteriology units, should be discharged to the outside with no recirculation.

To reduce the spread of odors in the histology unit, approximately 50 per cent of the exhaust from this unit should be removed at the fume hood over the work area, with the remainder being removed at the exhaust grille near the floor.

The serology-bacteriology unit should be slightly pressurized by supplying more air to it than is exhausted from it. This reduces the possibility of infiltration of aerosols from other areas which might contaminate the specimens being processed.

The administrative areas will require no special air conditioning design, although it is desirable that they be pressurized relative to the laboratory areas to eliminate laboratory odors.

Temperatures and humidities for all areas should be within the normal comfort units.

The air conditioning system should be designed to permit its extension to serve future expansion or rearrangement of the laboratory.

ELECTRICAL INSTALLATIONS

Voltage supplied to the laboratory outlets must correspond to the specific stationary or portable laboratory equipment to be used In the planning stage, after the major stationary equipment and areas have been determined, outlets for electric power can be arranged as to location and current characteristics required. Because of the variations in types of equipment, flexibility of the current characteristics and location of the electric power outlets are of primary importance throughout the laboratory. For example, portable and specially built apparatus may require 115 volts or 230 volts, depending upon the equipment model.

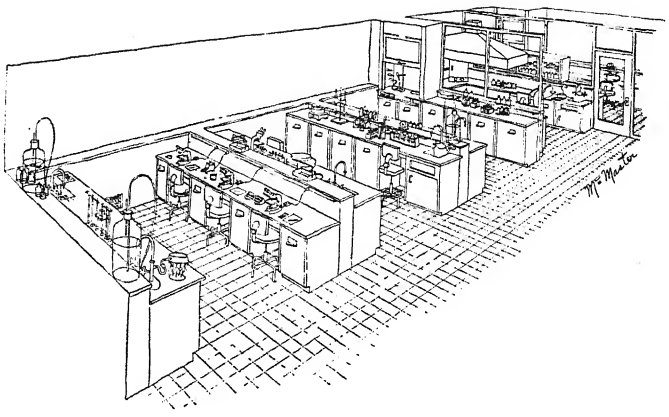
LIGHTING

Illuminating intensities at the laboratory workbenches should be a minimum of 50 footcandles, preferably produced by fluorescent lamps because they provide diffuse light sources with minimum glare. For close detail work, an illumination level of 100 footcandles is preferable. Figure 2 illustrates a typical lighting arrangement for each work area. In offices and areas where clerical work is performed, a minimum of 50 footcandles should be provided.

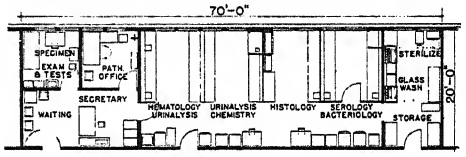
ROOM FINISHES

In the washing and sterilizing unit the floor finish should be waterproof, free of cracks, easy to clean, nonslip and resistant to wear from heavy traffic. A material such as quarry tile is satisfactory. Wall surfaces should be smooth, easy to clean, free of cracks, and have a waterproof finish. Glazed or similar finishes have been used satisfactorily.

In the technical areas there are no special requirements for finishes. Floor tiles such as asphalt, vinyl, and rubber have been used successfully. Tiles are preferable to sheet materials, since they are relatively easy to replace.



view of laboratory shown in Plan A (70,000-120,000 tests annually). This area is divided into five units, each 10 ft. wide. On the extreme left is the Hematology-Blood Bank Unit; next to it is the Urinalysis-Biochemistry Unit; in the center is the Biochemistry Unit, followed by the Histology Unit. In the background, behind the glass partition is the Serology-Bacteriology Unit



Plan D Alternate Plan
(40,000-75,000 Tests Annually)

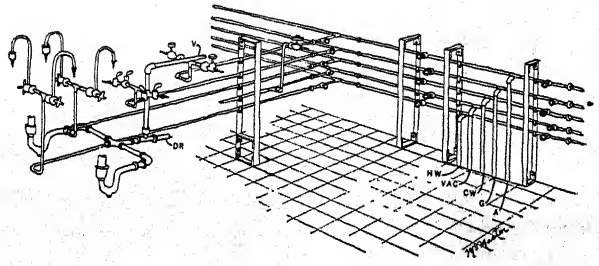


Figure 1. Laboratory Piping Diagram

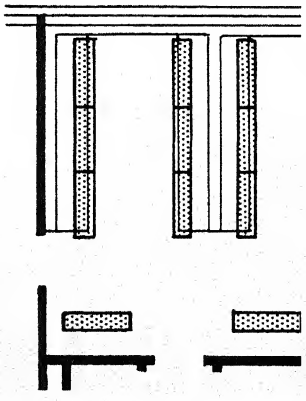


Figure 2.
Typical Work Area Lighting

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